Utilizing Photoelectromagnetic Degradation Imagery for Enhanced Forensic Assessment

Andrew A. Lehti

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Abstract

Photoelectromagnetic (PEM) imagery offers advanced capabilities for analyzing digital image degradation by capturing and visualizing electromagnetic spectrum characteristics. This paper presents a technique that utilizes repeated photo degradation to reveal hidden aspects of the electromagnetic (light) spectrum, such as refraction, direction, intensity, and light type. The method provides new insights into light behavior in digital media, distinguishing between artificial and natural light sources. PEM imagery, therefore, supports both image quality analysis and comprehensive light spectrum assessment, enhancing our understanding of image compression's impact on visual fidelity and spectrum visibility.

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1. Introduction

In digital imaging, compression can introduce significant artifacts that compromise image quality, especially in applications demanding high fidelity. Traditional methods assess these impacts using computational metrics that may miss subtle electromagnetic variations. This study introduces a PEM-based technique designed to repeatedly degrade images, making visible the electromagnetic spectrum and other hidden qualities such as light direction, type, and intensity. This approach not only captures compression artifacts but also enables enhanced visualization of light sources, distinguishing between artificial and natural lighting based on spectrum characteristics.

2. Photoelectromagnetic Imagery and Light Spectrum Analysis

Photoelectromagnetic (PEM) imagery captures material properties by detecting electromagnetic responses, such as light refraction, reflection, and dispersion across the image surface. Through repeated degradation, subtle spectrum details become visible, revealing information about light type, source, and intensity not easily seen with standard processing.

Technique Overview:

1. **Repeated Image Degradation**: Repeated compressive degradation emphasizes electromagnetic variations across the light spectrum. Each stage makes underlying qualities more visible, revealing spectral hues and directional shifts.

2. **Light Spectrum Characteristics**:

    - **Artificial Light**: Appears smooth with visible uniformity, often revealing yellow, black, or purple hues. Common household bulbs display an RGB spectrum, showing light frequency but limited range and variability.
    - **Natural Light**: Sunlight, as well as some high-energy bulbs, exhibit a CMYK spectrum, indicating a fuller spectrum and richer refractive details, reflecting both frequency and color separation across cyan, magenta, yellow, and black.

3. **Application of PEM in Compression Analysis**: This PEM-based technique leverages pixel-by-pixel difference imaging to visualize the degradation artifacts while also providing detailed insight into light composition and origin.

2.1. Enhanced Processing Function: `processPEMImage`

```
from PIL import Image, ImageChops, ImageEnhance
import os

def processPEMImage(imagePath):
    im = Image.open(imagePath)
    tfn = imagePath.replace('.jpg', '.tmp.jpg')
    pfn = imagePath.replace('.jpg', '_pem.jpg')
    im.save(tfn, "JPEG", quality=5)
    tmi = Image.open(tfn)
    pem = performPEMScan(tmi)  # Hypothetical function for PEM
scan
    pi = ImageChops.difference(im, pem)
    md = max(max(e) for e in pi.getextrema())
    s = 4850.0 / md
    pi = ImageEnhance.Brightness(pi).enhance(s)
    pi.save(pfn)
    os.remove(tfn)
```

3. Analysis and Results

By leveraging repeated degradation and PEM-based brightness scaling, the technique reveals subtle light behaviors:

- **Smooth Uniformity in Artificial Light**: RGB spectrum displays appear smoother with uniform, less complex refractions. Distinct hues, such as yellow or purple, highlight artificial sources.
- **Detailed CMYK Spectrum in Natural Light**: Natural light and high-energy bulbs reveal a fuller CMYK spectrum, with distinct separations, suggesting a broader range of electromagnetic frequencies and greater fidelity in color rendition.

4. Applications of PEM Imagery in Light Spectrum and Compression Analysis

PEM imagery has potential in various fields, including:

- **Digital Forensics and Security**: Detects tampering by examining light spectrum discrepancies and artificial artifacts.
- **Medical and Scientific Imaging**: Supports precise light and spectrum analysis crucial for diagnostic images requiring natural light qualities.
- **Machine Learning and AI**: Ensures high-quality, accurate light representations in training datasets, improving model input quality.

5. Conclusion

This PEM technique offers an innovative approach to compression analysis and spectrum visualization. By revealing hidden electromagnetic characteristics, it provides enhanced insight into light behavior, which can inform various industries on image quality maintenance, light assessment, and the subtle impacts of compression. Future applications may focus on real-time PEM processing for even more efficient spectrum-based quality assessments.

There is much work that needs to be performed, I conclude with this observation:

Violet + Green + Orange → Yellow
Violet + Green → Blue
All Colors → Black

Keywords: Photoelectromagnetic imagery, Image degradation, Electromagnetic spectrum, Light analysis, RGB spectrum, CMYK spectrum